Bulletin 798

• Silo Construction Costs and • Silage Production Practices

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SUMMARY

Three types of silos were found in common use on farms in the Blackland and Grand Prairie are of Texas. These were the unlined trench, the concrete-lined trench and the upright. The unlin trench was the most numerous of the three.

The cost of an unlined trench silo varied, on the average, from $90 for the 100-ton size to $122 f one of 200-ton capacity. Trench silos of similar capacity had been lined with concrete at costs rangi from $760 to $1,466. The cost of a concrete stave upright silo (100-ton capacity) was approximat $1,400, whereas a 200-ton silo of similar construction cost $2,040.

The annual cost of storing silage (depreciation, interest, upkeep and spoilage) in unlined and i concrete-lined trenches averaged approximately $1 and $1.40 per ton capacity regardless of size. Wit upright silos, the average annual cost per ton of storage ranged from $1.65 for the 100-ton size to $1. for those of 200-ton capacity.

On farms with crops yielding 12 tons of silage per acre, a crew of five men, two tractors and t trucks harvested 8 acres per day when filling trench silos. However, a crew of eight men and f tractors was required to put a similar yield in an upright silo.

With crops yielding only 4 tons of silage per acre, a crew of four men, two trucks and two trac averaged putting the production from 11 acres in a trench silo during a 10-hour day. In filling upri silos with crops yielding 3.6 tons per acre, a crew of six men and three tractors was required to har 11 acres per day.

The operation of 18 silage field cutters was studied in detail. These were single-row machi equipped with auxiliary engines and were used to harvest an average of 180 acres annually. The t cost of operating the cutter, together with its auxiliary engine, averaged $3.04 per acre. Opera costs for a tractor to pull the cutter and wages for the tractor driver amounted to an additional $ per acre.

CONTENTS

Silo Construction Costs and Silage Production Practices

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EFFICIENT PRODUCTION AND USE OF ROUGHAGE is one of the keys to greater profits on many Texas farms. Particularly is this true among dairy farmers. Good grazing is the best and usually the cheapest roughage. When good pasturage is not available, silage is the best succulent substitute. Recently the trend has been to increase greatly the use of silage on Texas farms, especially on dairy farms.

A study was made on 85 farms with silos to determine the cost of providing facilities for storing silage and the practices and requirements for growing and putting up silage. These farms were in the Blackland and Grand Prairie areas located in Denton, Cooke, Collin, McLennan, Bosque, Bell and Fayette counties (Figure 1).

TYPES OF SILOS STUDIED

Texas farmers have used several types of silos but only three were found in common use on the farms studied. These were the unlined trench, the concrete-lined trench and the upright types. Of the three, the unlined trench predominated.

Unlined Trench Silos

Description

Unlined trench silos are made by excavating a trench on a slope or on an area higher than the surrounding lots or fields. The lower end of the trench is left open for drainage. Excavating is done with a dragline or bulldozer, most usually the latter. Best results were reported where the silo was wider at the top than at the bottom, with the sides smoothed to a gradual slope from top to bottom. Some farmers smooth the walls by hand with a shovel after the bulldozer finishes. This type silo is dug either completely below ground level or the dirt that is removed is used to raise the banks on each side of the trench.

In localities where the water table is high or the land is flat, two levies of dirt can be mounded and silage stored between. This is referred to as an "upside-down" trench silo. Only one of the cooperating farmers had a silo of this kind.

Per farm capacity for storing silage tended to vary with livestock numbers. On the average, farmers with unlined trench silos had capacity to store 5 tons of silage per animal unit maintained. This compares with storage capacity of approximately 3 tons per animal unit on farms with either upright or lined trench installations. Most of the unlined trench silos studied were less than 300-ton capacity and there were two of less than 100-ton size. At the same time data were obtained for 11 unlined trenches of more than 400-ton capacity including one calculated to hold more than 1,700 tons.

Although there was considerable variation in width and depth of the silos studied, most of the variation in capacity was due to differences in length. A typical silo was 8 feet wide at the bottom, 12 feet wide at the top and 8 feet deep.

In building a trench silo, it is important that the cross section of the trench be proportionate to the size of the herd to be fed. The width and depth should be such that the right amount will be fed daily to prevent spoilage while feeding. The bottom should be planned wide enough to accommodate the use of both the earth-moving machinery and the equipment used in packing.

The amount of silage that can be stored in a particular size trench depends on the kind and

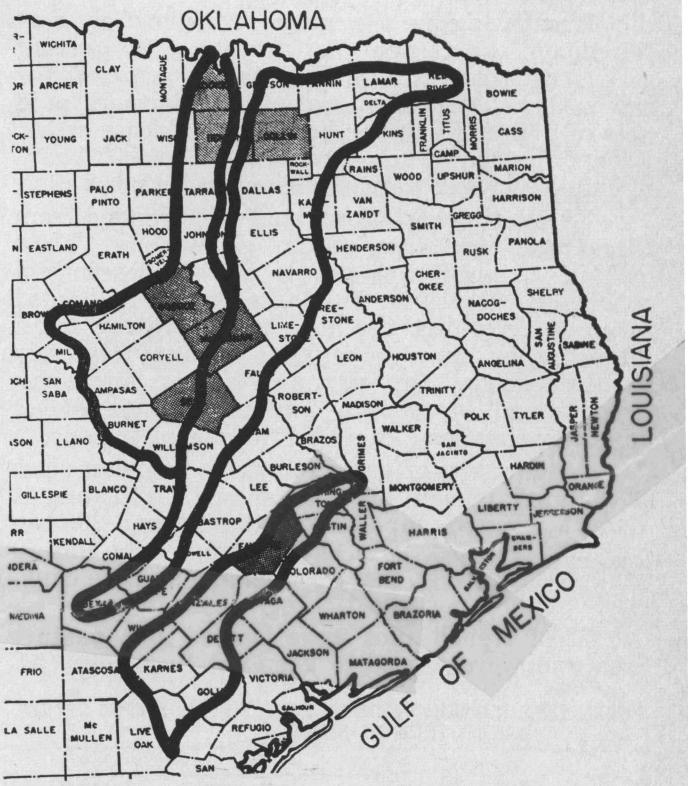

Figure 1. The heavy black lines show the approximate boundaries of the Texas Blackland and Grand Prairie areas. The shaded parts indicate the counties in which the study was made. Area delineation adapted from Texas Agricultural Experiment Station Bulletin 544, "A Description of the Agriculture and Type-of-farming Areas in Texas."

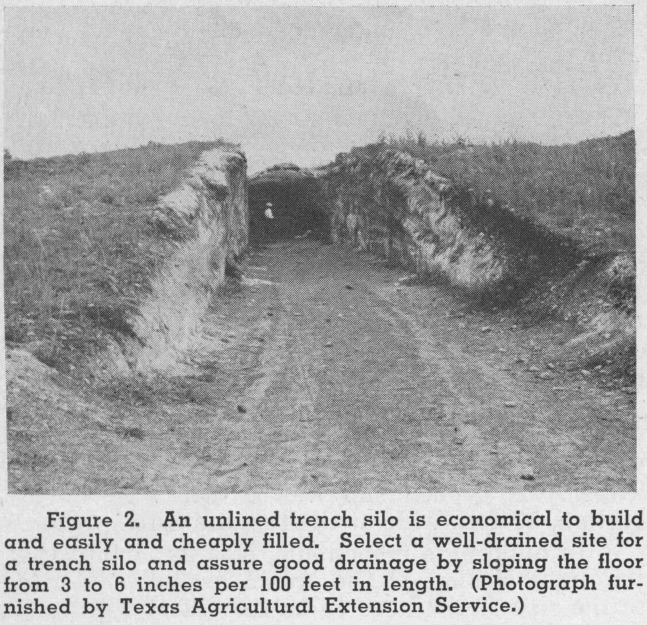

Figure 2. An unlined trench silo is economical to build and easily and cheaply filled. Select a well-drained site for a trench silo and assure good drainage by sloping the floor from 3 to 6 inches per 100 feet in length. (Photograph furnished by Texas Agricultural Extension Service.)

condition of the crop used for silage, the amount of grain, the fineness of the cut, the amount of moisture present and how well the silage was packed at filling time. The capacity of the trench silos in the study was calculated on the basis of a cubic foot of silage weighing 40 pounds or 50 cubic feet per ton.

Cost of Construction

Excavating is the major construction cost for an unlined trench silo. In about 85 percent of the cases studied, a bulldozer was used for excavating. With few exceptions, farmers paid between $8 and $10 per hour for bulldozer work. Except for the larger excavations, 6 to 10 hours of bulldozer work were sufficient to dig most silos.

Excavating costs for trench silos ranged from 25 cents to $1 per ton of storage capacity. Most of this variation was due to differences in soil condition. However, bulldozer operators tended to move more dirt per hour in excavating for a large trench than in making one of relatively small capacity. On individual farms, stoniness, dryness and topography had much more effect on excavating costs than did the size of the silo.

A summary of costs for three common sizes of unlined trench silos is shown in Table 1. Excavating costs for 100-ton, 150-ton and 200-ton capacity trenches were 65 cents, 50 cents and 40 cents, respectively, per ton of silage storage capacity.

Most trench silos were located in a pasture area and were fenced to keep out livestock. Although some farmers used woven wire, trench silos usually were enclosed with 4 barbed wires on cedar posts. Cost of this kind of fencing ranged from $25 for the 100-ton silo to $42 for a silo of greater length and with 200-ton capacity.

TABLE 1. SUMMARY COSTS FOR THREE SIZES OF UNLINED TRENCH SILOS

Item	Capacity of silo		
	100 tons	150 tons	200 tons
	Dollars	Dollars	Dollars
Excavating	65.00	75.00	80.00
Fence enclosing silo	25.00	34.00	42.00
Total cost	90.00	109.00	122.00
Per ton capacity	.90	.73	.61

For an investment of $90, Blackland and Grand Prairie farmers provided storage for 100 tons of silage in unlined trenches. On the average, the per-ton cost of this type storage decreased some as the size of silo was increased. By investing only about $125 (Table 1), other farmers provided storage for 200 tons of silage at a cost of 61 cents per ton capacity.

It has been recommended (Extension Bulletin 186) that Texas dairymen provide at least 3 tons of silage for each cow in the herd. Farmers in the Blackland and Grand Prairie areas have constructed sufficient storage in trenches at costs averaging $1.80 to $2.70 per cow.

In this part of the State, the unlined trench will provide silage storage facilities at a much lower construction cost than either lined trenches or upright silos. For comparisons see Tables 2 and 3.

Advantages and Disadvantages

The unlined trench silo has the advantage of cheap construction and offers many opportunities for labor saving in filling. With field harvesters, cutting, hauling and unloading was mechanical and trench silos were easily and cheaply filled without use of a blower. Packing, which is one of the most important operations in the making of good silage, was effectively and economically done by running a tractor over the chopped material. A relatively small crew was required for filling trench silos. This is particularly important when labor is scarce, as is usually the case during harvest. Also there were opportunities to save labor when feeding from trench silos. By using tractor-mounted equipment, silage was loaded rapidly and economically into a truck or trailer. In one case where the silo was near the feed lot, silage was taken from the trench to the feed bunks by a tractor scoop.

The amount of spoilage with trench silos differed considerably from farm to farm and even varied from year to year on the same farm. As a rule, farmers with experience in making silage had less spoilage than those who put up silage for the first time. Loss from spoilage usually was closely associated with the thoroughness with which silage was packed while filling. With reasonable care, spoilage did not exceed 10 percent in the trench silos studied and in many cases was even less. The surface area of a trench was much greater than that of an upright silo. Consequently, between the two types, surface spoilage was greater for the trench.

Even when well drained, silos with dirt floors tended to become muddy and were hard to get into and out of during rainy weather. For this reason some farmers covered the silo floor with a layer of gravel.

The life of an unlined trench silo depends, to a large extent, on the type of soil in which it is located. In some areas of the State, the soil types are such that dirt walls hold for several years with relatively little caving or sloughing off. Under these conditions, unlined trench silos deteriorated slowly and there was little upkeep. On one of the cooperating farms, silage had been stored in an unlined trench each year for 12 years and the silo was still in excellent condition. However, with other soil conditions, it was noted that the walls had caved badly after only 1 or 2 years' use. Here the life of an unlined trench silo was relatively short. Farmer experience indicated an unlined trench silo can be used for an average of 5 years or longer in the parts of the State included in the study.

The precautions which need be considered in building a trench silo are discussed in Extension Circular 328. Briefly, the location should be on a well-drained site and drainage water from slopes above should be diverted from the silo. Do not select a site where this cannot be done. In most parts of the State, it is necessary to have sufficient slope of the site to permit ample drainage from the open end of the trench. Good drainage throughout the entire length of the silo is necessary to eliminate as much mud as possible when feeding from an unlined trench.

A convenient location and approaches and roads which permit silage removal in all kinds of weather are important.

Lined Trench Silos

Description

A trench silo can be made more permanent by concreting the floor and lining the walls with concrete or masonry. This type of silo has proved satisfactory over a period of years. Concrete was the most common material used in lining trench silos on the farms studied. However, in a few cases the walls had been lined with concrete blocks or similar materials. Farmers reported satisfactory experience with both methods of construction.

Some of the trench silos on the farms studied were lined when built. Others had been used a season or more without lining. Farmers who, because of soils that cave or slough off easily, had experienced difficulties in maintaining unlined trenches solved their problem by concreting the floor and walls to make an excellent type of permanent silo. There were a few trench silos with concrete floor and dirt walls. It was not uncommon for the floor to be concreted one year and the walls to be lined later. In this way, construction costs were spread over a period of 2 or more years.

Cost of Construction

A summary of the materials required and the construction costs for three sizes of lined trench silos (100, 150 and 200-ton capacity) are shown in Table 2. These data are for a silo 8 feet deep, 8 feet wide at the bottom, 12 feet wide at the top

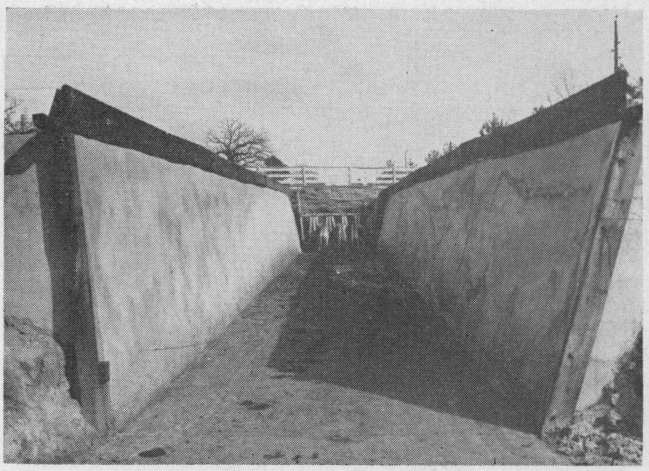

Figure 3. Trench silos lined with concrete are permanent and have proved satisfactory over a period of years for Texas conditions. Here the silo is equipped for self-feeding as a means of saving labor. (Photograph furnished by Texas Agricultural Extension Service.)

and with uniformly sloping sides. With these dimensions, a silo must be approximately 60 feet long to hold 100 tons and approximately 95 feet long to hold 150 tons. To store 200 tons of silage requires a trench of the same depth and width and 125 feet in length.

The costs for both excavating and fencing to enclose the silo are the same for a lined as for an unlined trench of similar capacity.

As shown in Table 2, the amounts of materials required for lined trench silos are for a 6-inch concrete floor and 5-inch concrete walls, reinforced by welded wire and by half-inch steel rods spaced 10 inches apart. For the walls, the concrete mix used in making these calculations was 1 sack of cement to 2.25 cubic feet of sand and 3 cubic feet of gravel. In figuring for the construction of the floor, a mix of 1 sack of cement to 2.5 cubic feet of sand and 4 cubic feet of gravel was used.

The usual practice in constructing a silo of this type was to pour the floor first. In some cases the trench wall was poured in sections with forms built in panels for ease in handling. Sometimes one wall was built at a time to reduce the amount of lumber required for forms and to reduce cost proportionately. In other cases, forms were built for a single continuous pour. The number of board feet required for form materials, as shown in Table 2, was based on the continuous-pour method.

The purchase price of new lumber used in constructing forms for concrete ranged from $216 for the 100-ton to $396 for the 200-ton capacity silo. In most cases, farmers had to buy new materials and thus incurred similar expense in the construction of silos of this type. However, since most of the lumber used as forms was later re-used for other purposes about the farm, only 30 percent of the cost new was charged to silo construction.

TABLE 2. SUMMARY OF MATERIALS AND COSTS FOR THREE SIZES OF LINED TRENCH SILOS

Item	Unit	Capacity of silo					
		100 tons		150 tons		200 tons	
		Amount	Cost	Amount	Cost	Amount	Cost
			Dollars		Dollars		Dollars
Excavating	——	——	65.00	——	75.00	——	80.00
Cement	Sack	163	179.30	246	270.60	330	363.00
Sand	Yard	14	56.00	20	80.00	28	112.00
Gravel	Yard	18	54.00	28	84.00	37	111.00
Reinforcing:							
No. 6, 6 x 6" welded wire	Foot	1,740	95.70	2,635	144.92	3,535	194.42
½" steel bars	Lbs.	368	36.80	565	56.50	750	75.00
Labor:							
Forming and steel placing	Hrs.	176	105.60	254	152.40	352	211.20
Pouring	Hrs.	130	78.00	197	118.20	265	159.00
Form materials	Bd. ft.	2,400	64.80[1]	3,500	94.50[1]	4,400	118.80[1]
Fence enclosing silo	——	——	25.00	——	34.00	——	42.00
Total Cost	——	——	760.20	——	1,110.12	——	1,466.42
Per ton capacity	——	——	7.60	——	7.40	——	7.33

[1] Cost of materials used in building forms figured on the basis that 70 percent of the value of such materials was salvaged for other uses.

With prices prevailing at the time of the study, the construction costs of providing silage storage in a concrete-lined trench was approximately $7.50 per ton, regardless of the capacity. The amounts of each kind of material used in construction varied proportionately with storage capacity. It was possible to effect some saving in construction costs by increasing the width and depth of the silo. This is practical only where large herds of beef or dairy cattle are being maintained.

On the basis of 3 tons of silage needed per dairy cow, an investment of about $22.50 was required per cow to provide this type of storage. This was several times the investment required with an unlined trench but somewhat less than was required for storage in an upright silo.

Advantages and Disadvantages

The added cost is the only disadvantage of the lined compared with the unlined trench silo. The lined silo has the advantage of permanency. Most lined trench silos on cooperating farms were relatively new. However, those of older construction were requiring little or no upkeep and indicated that when constructed properly, trench silos with concrete walls and floor should be serviceable for many years.

Concreting the floor does away with any difficulties of getting in and out because of mud in the bottom of the silo during rainy periods.

Other things being equal, spoilage for the lined and unlined trench was about the same. In each case, farmer experience was that about 8 percent of the total feed going into the trench became spoiled prior to feeding.

Several dairymen among the cooperating farmers expressed their intention to concrete unlined trenches and equip them for self-feeding, thus saving the large amount of labor required to get silage into the feed trough. A hard, even floor is required for a self-feeding trench silo. In most soils, the walls also need to be lined. Once the trench was lined, the additional cost to install a gate for self-feeding was small. Of the different types of silos included in the study, the lined trench was the only type suited to self-feeding.

Other advantages common to both the lined and unlined trench silo were economy during filling, ease of packing and opportunities to save labor in feeding. Tractor-mounted equipment is particularly well-suited to loading silage from the lined trench.

The same precautions for a convenient location that is accessible at all times and for proper slope and drainage apply equally to both the lined and the unlined trench.

Upright Silos

Description

Data were obtained from 21 farmers owning 29 upright silos. These ranged in capacity from 68 to 254 tons. The most common dimensions included diameters of 12, 14 and 16 feet with heights of 40 to 50 feet. Of the 29 uprights, 20 were constructed of tongue and groove or interlocking concrete staves or blocks, 4 were solid concrete, 4 were steel structures and 1 was plaster over metal plaster lathe.

All upright silos were on concrete foundations. Those of concrete stave or block construction were plastered inside and were without covering on top. The steel uprights were of specially-treated galvanized steel sheets bolted together and came equipped with tops. The solid concrete silos on the farms studied were old structures that had been poured in sectional forms.

Cost of Construction

Materials for the concrete stave or steel structures were purchased on a contract basis. Usually the contract price did not include labor and materials for the foundation, labor for erecting the silo, nor labor and materials for plastering.

Cost data shown in Table 3 are for concrete stave upright silos of three capacities—100, 15

and 200-ton. This type of structure and these capacities were most representative of the uprights studied.

There were small farm-to-farm differences in the contract cost of materials for similar construction and capacity of upright silos. In part, this was due to differences in dimensions (diameter and height) for silos of similar capacity. Also, freight costs varied, depending on the location of the farm and where the silo was purchased. The cost of contract materials and freight, as shown in Table 3, are for silos of dimensions (both diameter and height) common to farms included in the study. Other costs of building an upright silo include cement; sand and gravel for the foundation and for plastering the inside walls; half-inch steel to reinforce the foundation; and labor furnished by the farmer to lay the foundation, erect the silo and plaster the walls.

Silage storage was provided by an upright silo 12 feet in diameter and 45 feet high (100-ton capacity) for an investment cost of $14 per ton. This was about $6.50 per ton more than the cost on farms using a concrete-lined trench of the same capacity (Table 2) and was many times the cost when unlined trenches were used (Table 1). However, in the case of upright silos, construction costs decreased substantially when larger silos were built. With a 200-ton concrete stave silo, it was necessary to invest only $10.20 per ton capacity. This was less than 75 percent of the per-ton cost of the 100-ton size and represented a saving of about $4 in the cost of building storage for a ton of silage.

Although the larger the upright silo the lower the cost per ton of storage capacity, there is a practical limit to the possible saving. Most farmers do not want a silo much taller than 50 feet. At the same time, each foot increase in diameter increases greatly the feeding necessary to keep silage fresh and to avoid additional spoilage during feeding. Consequently, the size of herd puts a limit on the diameter that is practical.

With upright silos, the cost of providing storage for the minimum silage needs per dairy cow ranged from $42 in the case of 100-ton capacity to $31 with the 200-ton size.

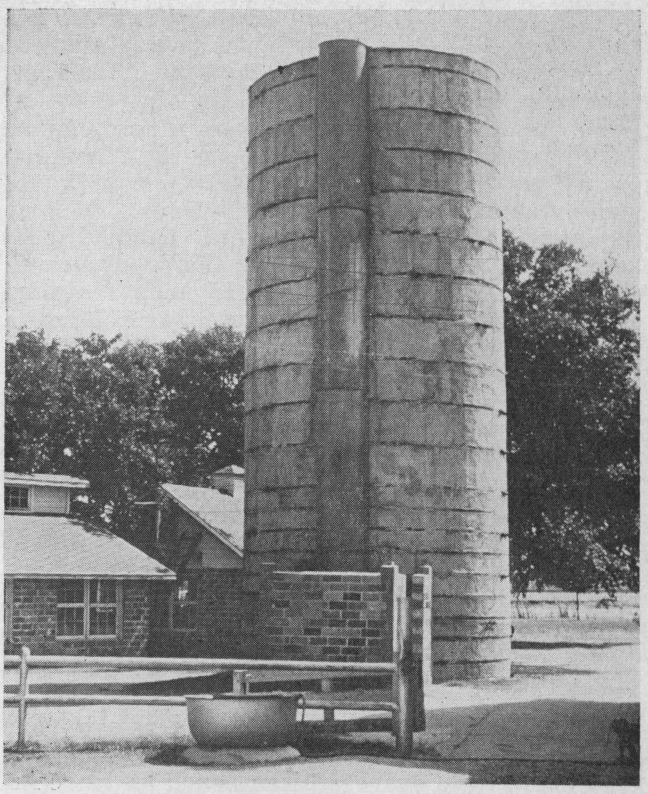

Figure 4. The upright silo is one of the best types for a permanent silage program. Upright silos are built of concrete staves, concrete blocks, solid concrete, tile, brick, metal and wood. (Photograph furnished by Texas Agricultural Extension Service.)

Advantages and Disadvantages

Upright silos have the disadvantage of high initial cost. This is particularly noticeable in the case of small-capacity uprights and is also noticeable in comparison with the initial cost of any size of unlined trench silo. Furthermore, special equipment is required for filling an upright silo. Packing (a very important operation in making silage) was done effectively and cheaply with tractors in the case of trench silos. But farmers with upright silos used large amounts of expensive labor to get silage packed properly.

An upright silo is permanent and attractive. This type silo requires only a little space and

TABLE 3. SUMMARY OF MATERIALS AND COSTS FOR THREE SIZES OF UPRIGHT SILOS

Item	Unit	Capacity of silo					
		100 tons		150 tons		200 tons	
Dimensions of silo:							
Diameter	Feet	12		14		16	
Height	Feet	45		50		50	
Amounts and costs		Amount	Cost	Amount	Cost	Amount	Cost
			Dollars		Dollars		Dollars
Contract materials and freight	——	——	1,300.00	——	1,750.00	——	1,850.00
Cement for foundation & plaster	Sacks	20	22.00	30	33.00	40	44.00
½-in. steel for foundation	Feet	120	6.00	150	7.50	175	8.75
Sand and gravel for foundation	Yards	4	12.00	6	18.00	8	24.00
Sand for plaster	Yards	1	5.00	1	5.00	1	5.00
Man labor for foundation	Hours	30	18.00	40	24.00	50	30.00
Erect & plaster	Hours	70	42.00	100	60.00	130	78.00
Total cost	——	——	1,405.00	——	1,897.50	——	2,039.75
Cost per ton capacity	——	——	14.05	——	12.65	——	10.20

usually can be located conveniently to feed lots and barns. The use of uprights is less affected by adverse weather than is true with trenches, especially unlined trenches with dirt bottoms. Also, a relatively small proportion of the roughage stored is exposed in uprights. When filled and packed properly, there was less spoilage in uprights than in trench silos. However, to keep spoilage at a low level in uprights, care had to be taken to get a good seal around the doors as well as to pack the top carefully to keep it sealed against the wall while settling. Some farmers reported heavy spoilage in uprights when proper precautions were not taken. With the exception of these occasional heavy losses, spoilage reported by cooperating farmers averaged about 4 percent of the total feed going into upright silos.

Some farmers object to the high climb necessary to reach the top of an upright silo. Also, all the silage fed from this type silo was forked by hand, whereas several farmers with trench silos loaded silage mechanically at a great saving in labor.

ANNUAL COSTS FOR STORING SILAGE

After a silo was completed, the year-to-year costs of maintenance were relatively light. However, there were overhead items such as depreciation and interest on investment to consider. A summary of the annual costs, both out-of-pocket and overhead, associated with storing silage in three types of silos, is shown in Table 4.

Most trench silos were cleaned out before filling and it was considered good practice to smooth the sides of those with dirt walls. Smoothing the walls was done by hand just prior to cleaning. Cleaning took only a short time with a tractor blade. Upright silos were cleaned entirely by hand.

Some door repair was necessary each year with most uprights. Doors usually had to be replaced at 6 to 8-year intervals. It was common also to use felt paper and heavy paint to improve the seal around the doors. Spoilage losses around the doors were heavy unless special care was taken. For concrete stave or block uprights, an occasional painting of the walls was considered desirable to protect and extend the life of the plaster. Both the inside and outside walls of metal silos should be painted periodically. In some cases, trench silos lined with concrete blocks were painted occasionally to help maintain a good seal. However, this practice was not followed by farmers whose trench silos were lined with poured concrete.

Numerous precautions were taken to reduce spoilage but such losses were not avoided entirely with the types of silos studied. In this study, spoilage losses were considered as an annual cost associated with having a supply of silage. Careless management can easily result in much greater spoilage than estimated, which in turn would increase annual costs above the estimates used in Table 4.

Yearly costs for storing silage in an unlined trench amounted to only about $1 per ton capacity. Here, the low initial cost more than offset a relatively high charge for spoilage when compared with more expensive type construction. The investment necessary for concreting a trench, together with little or no reduction in spoilage, resulted in annual costs of about $1.40 per ton capacity. With both lined and unlined trenches, there was little difference in annual per-ton costs between the 100 and 200-ton size. However, in the case of concrete stave uprights, there was economy in building the larger size structure.

SILAGE PRODUCTION PRACTICES

Cooperating farmers reported success in making silage from a variety of crops. Corn was the crop used most frequently. However, much of the acreage of corn going into silage on the farms studied was not planted as a silage crop. Because of the drouth, much corn that was otherwise a failure was salvaged for silage. Forage sorghums were second to corn in the acreage used for silage. Sorghums most commonly used included Atlas, Honey Drip, Red Top and Hegari. Some Sudan went into silage and in the northern counties included in the study, a sizable acreage of oats was used. Other crops used for silage were Johnsongrass, clover and grass mixtures.

TABLE 4. SUMMARY OF ANNUAL COST OF STORING SILAGE IN THREE TYPES OF SILOS

Item	100-ton capacity			200-ton capacity		
	Unlined trench	Lined trench	Concrete stave upright	Unlined trench	Lined trench	Concrete stave upright
Initial cost, dollars	90.00	760.20	1,405	122.00	1,466.42	2,039.75
Estimated years of life	5[1]	20	20	5[1]	20	20
Estimated spoilage, percent	8	8	4	8	8	4
Estimated spoilage, tons	8	8	4	16	16	8
Annual costs:	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.
Depreciation	14.25	38.01	70.25	18.10	73.32	101.99
Interest on investment	2.25	19.00	35.12	3.05	36.66	50.99
Spoilage at $10 per ton	80.00	80.00	40.00	160.00	160.00	80.00
Materials & labor upkeep rep.	3.50	2.50	20.00	5.00	4.00	25.00
Total annual cost	100.00	139.51	165.37	186.15	273.98	257.98
Annual cost per ton capacity	1.00	1.40	1.65	.93	1.37	1.29

[1] Applies to trench only. Life of fence estimated at 20 years.

In general, both the 1953 and 1954 crop seasons were relatively dry throughout the area studied. In many cases, the silage yields were low, reflecting drouth conditions. Yields of silage on the farms studied ranged from 2 to 14.2 tons per acre. In many cases, the acreage planned for silage did not yield the desired tonnage. Numerous farmers, particularly dairymen, finished filling their silos by purchasing corn or other crops in the field from neighbors. In some instances, field-cut feed was hauled several miles for this purpose.

Practices Prior to Harvest

More seed were used with corn planted for silage than when planted for grain. For a silage crop, a seeding rate of 9 to 10 pounds per acre was usual. Sorghum crops for silage were planted in rows and 12 pounds per acre was the usual seeding rate.

Seedbed preparation, planting and cultivation of corn was similar whether grown for grain or silage. Likewise, forage sorghums were handled much the same prior to harvest, whether cut for silage or harvested for dry forage.

The usual practice for corn or forage sorghums was to flatbreak, one-way or disk land in the fall or early winter prior to bedding. Thirty-five to 40 percent also was harrowed. About two-thirds of the acreage was rebedded or the beds cultivated before planting. After planting, all corn was cultivated twice and about 25 percent was given a third cultivation. Forage sorghums were cultivated twice. When used for silage, neither crop was hoed.

With two-row tractor equipment, about 3½ hours of labor with a tractor were required per acre to grow a silage crop to harvest time.

Harvesting Practices

Tractor-drawn harvesters were used to chop silage in the field and load the chopped forage into trucks or trailers for hauling to the silo. Two trucks or two tractors and trailers usually could keep up with the field cutter. However, additional trucks or trailers were used in cases of high yields and long hauls. By having as many as three trailers available, and providing the yield was not heavy nor the haul long, it was sometimes possible for one man and tractor to do all the hauling from field to silo.

A few farmers kept a man on the truck to spread and load chopped feed as it came from the field cutter. This was not the common practice and was most likely to be done when the haul between the field and silo was long.

In unloading the chopped feed into a trench silo, the truck or trailer was either driven through the trench, backed into the silo, or was unloaded from the side of the trench.

If dump trucks were not available, a false floor of wire was used for dumping trucks or trailers. A satisfactory false floor was made of heavy gauge wire about 2 inches narrower than the inside of the bed and long enough to extend 6 inches or so past the rear end. The false floor extended the length of the truck bed and lapped up over the front endgate. Frequently two or three chains, running the length of the heavy gauge wire, were used to add the strength required in unloading. A pullbar of 2-inch pipe or 2 by 4's doubled and bolted together was satisfactory on the front end of the wire. To unload the feed, a chain or cable was hooked around the pullbar and the other end attached to a tractor. The chopped feed was then rolled back with the tractor. This same tractor was run back and forth over the feed to pack it. When equipped with a blade, this tractor also served as a means of spreading the dumped feed evenly. This, in turn, facilitated thorough and uniform packing. When the tractor at the silo was not equipped with a blade, some farmers kept a man in the trench to spread the dumped feed with a seed fork. Also, when chopped feed came into the silo rapidly, as was likely to be the case with a high forage yield, two men were kept at the silo—one to operate the tractor used for packing and the other to help unload and to help with the spreading.

A blower was used to elevate chopped feed into upright silos. Chopped material was unloaded from trucks or trailers by rolling the feed off gradually and feeding it into a conveyor leading to the blower. The blower usually was tractor-powered and was equipped to facilitate unloading trailers at a rate in keeping with the capacity of the conveyor. Silage was spread by hand in upright silos and was packed by manpower.

Some farmers always added some water in making silage, others seldom did. In general, water was added when needed for satisfactory packing.

Cooperating farmers reported having used or observed the experience of neighbors who used dirt, loose hay, chopped hay, baled hay, straw or weeds to cover silage stored in trenches during years past. Some continued the practice of covering silage. However, the most common opinion was that the saving in spoilage did not justify the extra labor necessary to cover and uncover silage stored in either trenches or uprights. On the other hand, it has been found desirable to cover trench silos when the silage is to remain in storage for a number of years as a feed reserve.

Labor and Power Requirements for Silage Harvest

Low-yielding crops were harvested with less time and labor per acre than was required to put relatively heavy yields of forage in a silo. This was true for both types of trench silos and for uprights. However, labor and power requirements per ton of silage decreased as yields increased.

Trench Silos

Other things being equal, the labor and power used for harvesting and filling a trench silo was the same whether it was lined or unlined. Conse-

quently, no effort was made to separate the two in the following discussion.

Labor and power requirements for harvesting and putting forage in trench silos are shown in Figure 5. Data are shown for farmers harvesting the highest yields, in contrast with those harvesting the lowest yields of silage. For this comparison, 20 percent of the farms studied were included in each group. All of the farms studied were included in each group was grown by the farmer harvesting it and there were no especially long hauls from the field to the silo as was often true when crops were purchased off the farm for making silage.

With crops averaging 12 tons of silage per acre, one man with a tractor and single-row cutter harvested an average of 8 acres in a 10-hour day. In most cases, two trucks were sufficient for hauling to the silo. However, in the case of a long haul or with extremely heavy feed, more trucks were used to keep up with the cutter. By using extra trailers as needed, two men with tractors and trailers could move a heavy yield of cut feed from the field to the silo. It was common practice to keep the field cutter busy and whenever possible the work for the remainder of the crew was planned with this in mind.

At the silo, one man with a tractor was primarily busy with spreading and packing the loose-chopped material. He also used the tractor to unload trailers and trucks that were not self-dumping. Another man was at the silo to help speed up unloading, assist with the spreading and regulate the use of water when water was added.

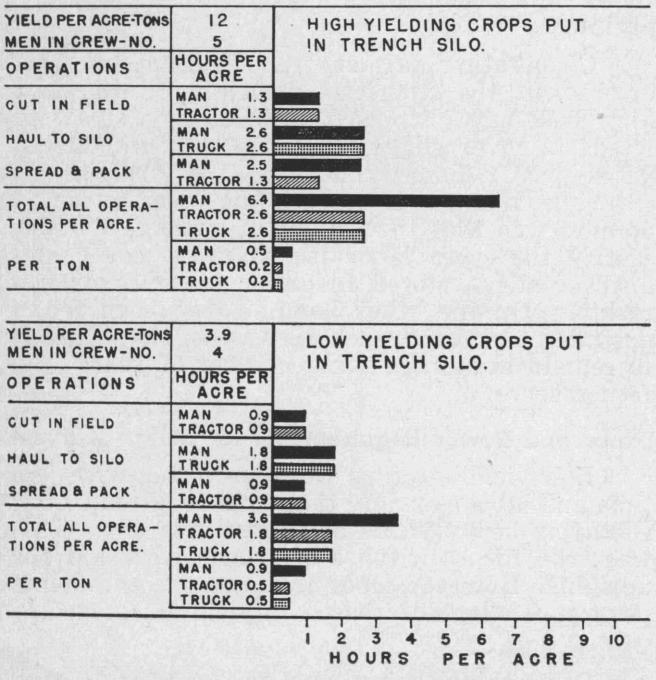

Figure 5. Labor and power requirements, per acre and by operations, to fill trench silos with high and low-yielding crops, 1953-54.

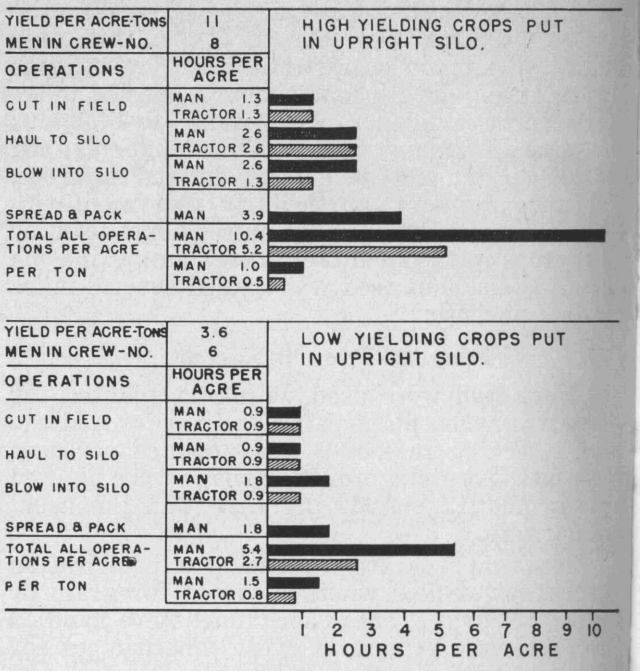

Figure 6. Labor and power requirements per acre and by operations to fill upright silos with high and low-yielding crops, 1953-54.

Farmers with crops yielding 12 tons of silage per acre used 6.4 hours of labor, 2.6 hours of tractor time and 2.6 hours of truck time for each acre stored in a trench silo. Stated differently, a crew of five men, two tractors and two trucks put up an acre of silage crop (yielding 12 tons) in 1¼ hours.

On the other hand, with low-yielding crops averaging about 4 tons of silage per acre, an average of 11 acres were harvested per 10-hour day with a field cutter. Here again most farmers used trucks in hauling to the silo. Two trucks were necessary but were not always busy if the haul was short.

An alternative practice was to use trailers instead of trucks. One man with a tractor and three trailers was able to keep up with a one-row cutter in low-yielding forages. When this was done, the usual practice was to have two men at the silo to handle the unloading, spreading and packing.

For crops yielding only about 4 tons of silage per acre or less, a total of 3.6 hours of labor, 1.8 hour of tractor use and 1.8 hour of truck time was required for each acre of crop stored in a trench silo. Under these conditions, four men, two trucks and two tractors averaged putting up an acre of silage crop in 54 minutes. However, labor requirements per ton of silage harvested were much greater for low-yielding than for high-yielding crops.

Upright Silos

Labor and power requirements for filling upright silos are shown in Figure 6. Here again requirement data for the farms harvesting the highest yields of silage are summarized separately

Figure 7. A field cutter chops silage in the field and loads the chopped material into a truck. This method permits efficient use of harvesting labor and is preferred where the supply of farm labor is limited. (Photograph furnished by S. B. Swigert.)

from data for those with the lowest silage yields. In both groups, all the silage harvested was grown by the farmer putting it up.

With similar yields, farmers harvested about the same acreage per day with a single-row cutter regardless of whether the chopped feed was going into a trench or an upright silo. Farmers with upright silos and with feed making 11 tons of silage per acre averaged cutting 8 acres per 10-hour day (1.1 hour per acre). This was the same rate as reported by those with similar yielding crops that were put in trench silos (Figure 5). Likewise, farmers cut 11 acres per day (.9 hour per acre) of low-yielding forage, irrespective of the type of silo being filled.

Farmers with upright silos tended to use trailers rather than trucks to haul from the field to the blower. This was true for both groups providing data summarized in Figure 2. Those with relatively high yields utilized two tractors and drivers for hauling to the blower. For low-yielding crops, one man with a tractor and three trailers could move the chopped feed to the blower. This practice cut hauling labor with low-yielding crops to less than 1 hour per acre or considerably less than half the time used to haul a relatively high yield of forage.

Two men were used at the blower regardless of whether chopped feed came in slow or fast. A tractor furnished the power to run the conveyor and the blower. Trucks and trailers were unloaded by dumping or with the aid of false floors or endgates. The blower crew took care of unloading and regulating the flow of chopped feed into the conveyor, operated the conveyor and blower and forked up feed spilled during unloading.

Farmers used two or three men in an upright silo to spread the feed as it came in, to tramp and pack and to fit the doors as filling progressed. When silage came in rapidly, as was true with high-yielding crops, three men were needed. However, with low-yielding crops, two men usually were sufficient in the silo.

For farms with the highest silage yields, approximately 10 hours of labor and 5 hours of tractor work were used per acre of feed going into upright silos. Here a crew of eight men and four tractors put up an acre of silage in 1¼ hours. Under these conditions the labor per ton of silage harvested was considerably less than was true with low-yielding crops.

All the extra labor required to fill upright silos as compared with trenches was used at the silo. With forage yielding an average of 12 tons of silage per acre, only 2.5 hours of man labor were used to get the material unloaded and to spread and pack it in a trench silo (Figure 5). But 6.5 hours of labor were needed to get about the same weight of silage elevated, spread and packed in an upright silo.

When upright silos were filled with crops yielding an average of 3.6 tons per acre, a crew of six men and three tractors put up an average of only 4 tons of silage per hour.

SPECIAL EQUIPMENT FOR FILLING SILOS

Regardless of silo type, a field cutter and two trucks or two or three specially-equipped trailers were needed to harvest silage crops. For filling upright silos, a blower equipped with a conveyor also was necessary. Two to four farm tractors completed the list of essential equipment.

Approximately one in three farmers making silage owned a field cutter. Those without field harvesting equipment contracted their cutting. Field cutting was done by the acre, by the hour or occasionally was charged for by the ton. Custom rates varied greatly from one community to another and ranged from $4 to $10 per acre when cut by the acre and $5 to $7.50 per hour when cut by the hour. These prices included a tractor to pull the cutter and a man to run each. In communities where cutters were numerous, rates tended to be lower than in communities with relatively few cutters.

TABLE 5. SUMMARY OF THE ANNUAL COSTS OF OPERATING SILAGE FIELD CUTTERS, 1953-54

Item	Per farm	
Number of farms studied		18
Cost of cutter new		$2,197
Estimated life—years		8
Acres cut per year		180
Hours worked per year		190
	Amount	Value
Fuel: (auxiliary engine)		Dollars
Gasoline—gallons	456	104.88
Oil—gallons	9	10.80
Other costs:		
Repairs (cutter and auxiliary engine)	xx	103.00
Depreciation		274.62
Interest		54.62
Total all costs (cutter and engine)		547.92
Cost per acre cut		3.04
Cost per acre, tractor use		.98[1]
Cost per acre, tractor driver		.63
Total per-acre costs, field harvesting	xx	4.65

[1] Data furnished by Willie L. Ulich, agricultural engineer, Texas Agricultural Extension Service.

Some farmers purchased field cutters with the idea of doing custom work. Others did field cutting for neighbors in exchange for help with their own silo filling.

Of 42 cutters, only five were equipped to handle broadcast feed. All others were single-row machines. Most of the machines were equipped with auxiliary motors, but a few operated by means of power take-off from the tractor.

Of the special equipment used in silo filling, the field cutter was the most expensive to buy and also to operate. Detailed information was obtained from 18 farmers as to the costs associated with owning and operating field cutters. A summary of these data is shown in Table 5. All of the cutters for which data were included in this summary were equipped with auxiliary engines.

There was considerable variation in the purchase price of various brands of cutters. Among the farms studied, $2,500 was the top price paid. The life of a cutter depends largely on its use. On the farms studied, cutters were expected to last an average of 8 years and cut an average of 180 acres annually.

Fuel consumption (for the auxiliary engine only) averaged 2.4 gallons per hour of operation. The amount of oil used varied considerably, but averaged approximately 2 quarts per day of operation, including the oil changes. The greater the use the greater the repair costs, but in most cases relatively high repair costs were reported.

The cost of operating the field cutter, together with its auxiliary engine, averaged $3.04 per acre. Other cost items incurred when silage was cut in the field were for the tractor used to pull the cutter and the tractor driver. The cost of operating the tractor was calculated to be 98 cents per acre. Rates paid tractor drivers varied, but at 60 cents per hour this cost amounted to 63 cents per acre.

Dump trucks used for hauling usually were hired since most farmers did not own this type of equipment. A common charge for dump trucks to haul chopped feed from the field to the silo was $2.50 per hour for the truck and the driver. Self-dumping trucks worked particularly well in trench silos. Regular farm trucks also were satisfactory when fitted with a false wire bottom for unloading with the aid of a tractor.

Most trailers used in filling trench silos had false wire bottoms and a back endgate or side that dropped to facilitate unloading. Most any farm trailer otherwise suitable could be used with minor adjustments without hampering its use for other farm hauling.

For filling upright silos, trailers with movable front endgates, used to push the load out the back, worked well in unloading the chopped feed into the hopper of the conveyor. A kit containing the items needed to equip a trailer for this purpose cost $65 to $75. Farmers reported this equipment would last about 8 years with annual repairs were needed when no trucks were used. Few amounting to $4 or $5. Three trailers usually farmers owned this many.

It often was a problem to get both tractors and trailers to fill silos. Tractors not owned by the operator were furnished by neighbors, either on an exchange basis or on a custom-rate basis. Frequently, neighbors pooled their equipment and worked together during silo filling. Three or four farmers working together and each contributing a tractor, a driver and a trailer (or a truck instead of a tractor and trailer) provided the necessary equipment.

A new blower, complete, to use with an upright silo cost $650 to $700 and would last about 10 years. Repairs on a blower, including conveyor and pipes, averaged approximately $10 annually. Less than half of those with upright silos owned blowers. When rented, the customary charge for the use of the blower was 25 cents per ton of silage.

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